

## CLAIMS

What is claimed is:

1. An image forming apparatus comprising:  
an image forming system configured to perform imaging operations;  
a waste toner system configured to accumulate waste toner resulting from the imaging operations; and  
a motor shared by the image forming and waste toner systems;  
said waste toner system comprising:  
a waste toner container to accumulate waste toner;  
a toner distributing member that is driven by the shared motor to distribute accumulated waste toner;
2. The image forming apparatus of claim 1, wherein the waste toner system further comprises:  
a motor control circuit to control the shared motor; and  
a logic circuit to detect accumulation of waste toner based on monitoring the motor control circuit while the shared motor is driving the toner distributing member.
3. The image forming apparatus of claim 2, wherein the motor control circuit comprises a speed control circuit configured to maintain the shared motor at a desired speed over a range of loading conditions, and wherein the logic circuit detects accumulation of waste toner by monitoring values of a speed control signal generated by the motor control circuit while the shared motor is driving the toner distributing member at a substantially fixed motor speed.

4. The image forming apparatus of claim 1, further comprising a drive apparatus that couples the shared motor to an image forming process member of the image forming system and to the toner distributing member, the drive apparatus comprising a selective engagement device to drive the toner distributing member in one direction of shared motor rotation but not in the other direction of shared motor rotation.
5. The image forming apparatus of claim 1, further comprising a locking system that locks and unlocks a drive apparatus associated with the toner distributing member responsive to removal and replacement, respectively, of the waste toner container from the image forming apparatus.
6. The image forming apparatus of claim 5, further comprising detection logic to detect a locked condition of the drive apparatus based on detecting a stall condition of the shared motor.
7. The image forming apparatus of claim 1, wherein the waste toner system further comprises one or more waste toner transport members configured to receive waste toner from the image forming system and transport the received waste toner to the waste toner container.

8. A waste toner system for use in an image forming apparatus wherein a motor in the image forming apparatus drives a toner distributing member used to distribute waste toner within a waste toner container, the waste toner system comprising:

a motor control circuit configured to maintain the motor at a desired motor speed over a range of motor loads; and

a logic circuit configured to detect accumulation of waste toner within the waste toner container by monitoring the motor control circuit.

9. The waste toner system of claim 8, wherein the logic circuit detects accumulation of waste toner within the waste toner container based on monitoring a speed control signal that is varied as needed by the motor control circuit to maintain the motor substantially at a desired speed while the motor is driving the toner distributing member.

10. The waste toner system of claim 8, wherein the motor control circuit is configured to vary a speed control signal as needed to maintain a desired motor speed, and wherein the logic circuit detects accumulation of waste toner by comparing one or more values of the speed control signal generated by the motor control circuit while driving the toner distributing member to one or more stored reference values corresponding to nominal waste toner accumulation conditions.

11. The waste toner system of claim 8, further comprising a locking system to lock a toner distributing member drive apparatus if the waste toner container is not present, and wherein the waste toner system is configured not to drive the toner distributing member responsive to detecting a locked condition of the toner distributing member drive apparatus.

12. The waste toner system of claim 8, wherein the logic circuit generates a full condition signal responsive to detecting a full condition of the waste toner container, whereupon the image forming apparatus prohibits image forming operations.

13. The waste toner system of claim 8, wherein the logic circuit generates a near full condition signal responsive to detecting a near full condition of the waste toner container, whereupon the image forming apparatus provides a near full warning to alert users of the image forming apparatus.
14. The waste toner system of claim 8, wherein the toner distributing member comprises a reciprocating toner rake, and wherein the logic circuit is configured to detect accumulation of waste toner within the waste toner container based on monitoring values of a speed control parameter generated by the motor control circuit over one or more raking cycles of the toner rake.
15. The waste toner system of claim 14, wherein the logic circuit detects a near full condition of the waste toner container by determining a difference between one or more values of a speed control parameter generated during one or more forward strokes of the toner rake and one or more values of the speed control parameter generated during one or more reverse strokes of the toner rake.
16. The waste toner system of claim 14, wherein the logic circuit detects a near full condition of the waste toner container based on determining a difference between maximum and minimum values of the speed control parameter generated over one or more raking cycles of the toner rake.
17. The waste toner system of claim 14, wherein the logic circuit detects excess accumulation of waste toner by comparing values of the speed control parameter generated over one or more raking cycles to one or more stored reference values corresponding to nominal waste toner accumulation conditions.
18. The waste toner system of claim 8, further comprising a drive apparatus coupled to the motor, the drive apparatus comprising:

a first drive apparatus configured to drive an image forming process member of the image forming apparatus in forward and reverse motor directions; and  
a second drive apparatus configured to drive the toner distributing member in one of the forward and reverse motor directions.

19. The waste toner system of claim 18, wherein the drive apparatus includes a one-way clutch coupling the second drive apparatus to the first drive apparatus, such that the first drive apparatus engages the second drive apparatus in one but not the other motor direction.

20. A waste toner system for use in an image forming apparatus wherein a motor in the image forming apparatus drives a toner distributing member used to distribute waste toner within a waste toner container, the waste toner system comprising:

a motor control circuit to vary a speed control signal as needed to maintain a desired motor speed; and

a logic circuit to detect excess accumulation of waste toner within the waste toner container by comparing one or more values of the speed control signal while the motor is driving the toner distributing member with one or more reference values corresponding to a nominal accumulation condition.

21. The waste toner system of claim 20, wherein the toner distributing member forms a part of the waste toner system and comprises a reciprocating toner rake movable in forward and reverse raking directions within the waste toner container.

22. The waste toner system of claim 21, wherein the logic circuit detects a near full condition of the waste toner container by detecting a difference between values of the speed control signal generated during forward and reverse portions of one or more toner rake cycles.

23. The waste toner system of claim 20, wherein the motor forms a part of the waste toner system, and additionally forms a part of an image forming system in the image forming apparatus, the waste toner system further comprising a drive apparatus that drives a media moving member and the toner distributing member in a first motor direction, and drives the media moving member but not the toner distributing member in a second motor direction.

24. The waste toner system of claim 20, wherein the motor comprises a dc motor and wherein the speed control signal comprises a pulse-width-modulated (PWM) output signal generated by the motor control circuit to vary a drive voltage of the dc motor.

25. A waste toner system for use in an image forming apparatus, the waste toner system comprising a shared motor that is configured to drive an image forming process member of the image forming apparatus and drive a toner distributing member that is used to distribute waste toner in a waste toner container.
26. The waste toner system of claim 25, further comprising a motor control circuit to control the shared motor, and a logic circuit to detect accumulation of waste toner in the waste toner container by monitoring the motor control circuit while the shared motor is driving the toner distributing member.
27. The waste toner system of claim 26, wherein the motor control circuit comprises a speed control circuit configured to vary a speed control signal as needed to maintain the shared motor at a desired speed, and wherein the logic circuit monitors the speed control signal to detect accumulation of waste toner within the waste toner container.
28. The waste toner system of claim 26, wherein the motor control circuit comprises a feedback control circuit configured to measure motor speed and to vary a speed control signal as needed to maintain the measured motor speed substantially at a desired motor speed.
29. The waste toner system of claim 25, further comprising a drive apparatus comprising:  
a first drive apparatus to drive the image forming process member in forward and reverse directions of the shared motor; and  
a second drive apparatus to selectively engage the first drive apparatus to thereby drive the toner distributing member in one motor direction but not in the other motor direction.

30. The waste toner system of claim 29, wherein the waste toner system is configured to maintain a first desired motor speed while driving both the image forming process member and the toner distributing member and to maintain a second desired motor speed while driving just the image forming process member.

31. The waste toner system of claim 29, wherein the waste toner system is configured to improve toner distribution by driving the toner distributing member during one or more periods selected so as not to interfere with image forming operations of the image forming apparatus.



32. A method of operation in an image forming apparatus that includes a waste toner system, the method comprising:

using a speed-controlled motor to drive a toner distributing member that distributes waste toner collected in a waste toner container; and  
detecting accumulation of waste toner based on monitoring a speed control signal that varies as needed to maintain a desired motor speed while driving the toner distributing member.

33. The method of claim 32, wherein detecting accumulation of waste toner based on monitoring a speed control signal comprises detecting an excess accumulation condition based on comparing monitored values of the speed control signal with one or more reference values corresponding to nominal accumulation conditions.

34. The method of claim 32, further comprising sharing the motor between image forming operations and waste toner distributing operations, such that the motor drives the toner distributing member and drives an image forming process member.

35. The method of claim 34, wherein sharing the motor between image forming operations and waste toner distributing operations comprises driving the image forming process member in both forward and reverse directions of the motor and driving the toner distributing member in one of the forward or reverse directions of the motor but not in the other direction.

36. The method of claim 32, wherein the motor is shared between toner distributing operations and image forming process operations, and further comprising selectively driving the toner distributing member such that it is driven when the motor runs in one process direction but not when the motor runs in an opposite process direction.

37. The method of claim 32, wherein the toner distributing member is a reciprocating toner rake, and wherein detecting accumulation of waste toner based on monitoring a speed control signal that varies as needed to maintain a desired motor speed while driving the toner distributing member comprises comparing monitored values of the speed control signal generated over one or more raking cycles to one or more reference values corresponding to nominal accumulation conditions.

38. The method of claim 32, wherein the toner distributing member is a reciprocating toner rake, and wherein detecting accumulation of waste toner based on monitoring a speed control signal that varies as needed to maintain a desired motor speed while driving the toner distributing member comprises detecting a near full condition based on comparing monitored values of the speed control signal generated during forward and reverse movements of the toner rake.

39. The method of claim 38, further comprising generating a near full warning signal.

40. The method of claim 32, wherein the toner distributing member is a reciprocating toner rake, and wherein detecting accumulation of waste toner based on monitoring a speed control signal that varies as needed to maintain a desired motor speed while driving the toner distributing member comprises detecting a full condition based on comparing maximum and minimum monitored values of the speed control signal generated during one or more raking cycles.

41. The method of claim 32, further comprising using the motor to drive an image forming process member in the image forming apparatus, such that the motor is shared between image forming operations and waste toner distributing operations.

42. The method of claim 41, further comprising configuring a drive apparatus to drive both the image forming process member and the toner distributing member in one motor direction and drive just the image forming process member in the other motor direction.

43. The method of claim 32, further comprising locking the toner distributing member responsive to removal of the waste toner container.

44. The method of claim 43, further comprising not energizing the motor responsive to detecting a locked condition of the toner distributing member.

45. A method of operation in an image forming apparatus that includes a waste toner system, the method comprising using a shared motor to drive both an image forming process member used in image forming operations of the image forming apparatus and a toner distributing member used to distribute accumulated waste toner collected in a waste toner container.
46. The method of claim 45, further comprising detecting accumulation of waste toner in the waste toner container based on monitoring a motor control circuit while the shared motor drives the toner distributing member.
47. The method of claim 45, wherein detecting accumulation of waste toner in the waste toner container based on monitoring a motor control circuit while the shared motor drives the toner distributing member comprises monitoring values of a speed control signal that is varied by the motor control circuit as needed to maintain a desired motor speed.
48. The method of claim 45, further comprising configuring the shared motor to drive both the image forming process member and the toner distributing member in one motor direction and to drive just the image forming process member in the other motor direction.
49. The method of claim 45, wherein using a shared motor to drive both an image forming process member used in image forming operations of the image forming apparatus and a toner distributing member used to distribute accumulated waste toner collected in a waste toner container comprises configuring the shared motor to drive a media alignment roller and the toner distributing member in a reverse process direction, and to drive just the media alignment roller in a forward process direction.

50. The method of claim 49, further comprising increasing operating times of the toner distributing member by running the motor in the reverse process direction at extra-process times selected not to interfere with the image forming operations.